

directly above, the elytral setae of *P. advena* each stand out distinct and well separated, but those of *P. setolineatus* are so bent back toward their neighbors as to give the impression of a continuous line, especially when viewed under low magnification. On *P. setolineatus* the elytral striae are broader than the intervals, but on *P. advena* the intervals are broader than the striae and their punctures are more distinctly defined. The obvious differences in shape of the antennal scapes and the apices of the tibiae are easily seen in the illustrations. The setae on the eyes of *P. advena* are conspicuous, but I am not able to ascertain if there are any setae on the eyes of *P. setolineatus* from the unique specimen at hand. A larger series might show that this species has a few microscopical setae on the eyes. The venter of *P. advena* is much duller than that of *P. setolineatus*.

Immigrant Species of *Drosophila* in Hawaii (Diptera: Drosophilidae)

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In 1939, Prof. Th. Dobzhansky arranged with Mr. Gordon Mainland, then at the University of Hawaii, to have stocks of *Drosophila melanogaster* sent from Hawaii to California for the purpose of conducting some experiments in crossing geographically isolated populations. Accordingly, some material which was identified in Honolulu as *D. melanogaster* was forwarded to Dobzhansky. The anticipated experiments were never carried out, because the Hawaiian flies proved to be *Drosophila simulans*—a closely allied species. An active interest in this problem was taken by the genetics seminar group which assembles at the University of Hawaii each week, and I, as the entomologist in the group, offered to do what I could regarding the situation. Various members of the seminar brought me specimens from several localities, and I trapped others about Honolulu. Cultures were established from this material and breeding experiments were conducted over a period of several months. This work revealed that there were at least six immigrant species in Honolulu (a seventh species was found recently).

The collections in local institutions had specimens of several immigrant species listed under the following four names: *D. melanogaster*, *D. immigrans*, *D. mulleri* and *D. repleta*. Study of part of these collections, including the softening of the dried and

shriveled specimens in KOH and dissections of the genitalia, revealed that none of the specimens studied was correctly identified, but not all of the specimens available were examined critically. One striking feature was that evidently none of the large series of specimens taken over a long period of time and labeled as *D. melanogaster* was that species, for all specimens studied were found to be *D. simulans*—a species not recorded from Hawaii.

By working with properly prepared material, including the living animals, it was possible to associate only three of the six species collected with described species. Living cultures of five of the six species were sent to the University of Texas where Dr. Patterson kindly bred them to known stocks of certain species. Two of these species proved to be new, and these have recently been described by Patterson and Wheeler.

D. melanogaster was not obtained for some time after this study was begun, but it was finally taken on the campus of the University of Hawaii and was later identified in material collected on Lanai. Since the first field capture of *D. melanogaster*, it has become abundant about Honolulu. It is suggested that *D. melanogaster* may be a recent immigrant to Honolulu—in spite of earlier references to its presence here—and that its apparent sudden appearance, rapid increase and spread in Honolulu may be attributed to escapes from culture bottles of the species imported from California for use by the classes in genetics at the University during the past few years. However, the species may have been present before 1920 and may have been locally replaced by *D. simulans*. The problem warrants further investigation.

The conclusions reached are as follows: *D. immigrans* Sturtevant, *D. repleta* Wollaston and *D. mulleri* Sturtevant, heretofore recorded in Hawaiian literature as present in the islands, were not found during this research. The species confused with *D. immigrans* is *D. spinofemora* Patterson and Wheeler; the species misnamed *D. repleta* and *D. mulleri* are *D. hydei* Sturtevant and *D. mercatorum* Patterson and Wheeler. Thus, the species *immigrans*, *repleta* and *mulleri* evidently should be removed from the Hawaiian list.

A revised list of the immigrant species known to me at this writing is as follows:

1. ***Drosophila (Drosophila) hydei*** Sturtevant, Carnegie Institution of Washington, publication 301, p. 101, 1921.

This species is an immigrant from America. It is especially abundant in pineapple fields.

2. ***Drosophila (Drosophila) mercatorum*** Patterson and Wheeler, University of Texas publication 4213, p. 93, 1942.

This species is known also from the southern United States.

3. ***Drosophila (Drosophila) spinofemora*** Patterson and Wheeler, University of Texas publication 4213, p. 103, 1942.

Although this species has been found thus far only in Hawaii, it is probably an immigrant from the United States. It is the commonest species about Honolulu where it develops in enormous numbers and may occur in almost pure populations.

4. ***Drosophila (Sophophora) montium*** de Meijere(?), Tijds. voor Entom. 59: 205, 1916.

This species is evidently widespread from Malaysia and Japan to Samoa. I have been unable to capture females, and thus have not been able to breed the species. Only a few males captured at a decaying fruit trap in Kaimuki, Honolulu, have been seen. I list my determination with a question until additional material can be obtained for study.

5. ***Drosophila (Sophophora) ananassae*** Doleschall, Nat. Tijds. Neder. Ind., 17: 128, 89, 1858.

This species was not collected until recently while I was gathering these notes together for publication. I have taken it rather commonly at fruit bait at Bishop Museum during November and December of this year. The species was originally described from Amboina, but is now widespread in the Oriental and American tropical and subtropical regions. Dried specimens might be confused with the following two species, but the single prominent bristle on each palpus is a good character to use for its differentiation.

6. ***Drosophila (Sophophora) simulans*** Sturtevant, Psyche, 26: 153, 1919.

An Old World species, but probably an immigrant to Hawaii from America, and now almost cosmopolitan.

7. ***Drosophila (Sophophora) melanogaster*** Meigen, Syst. Besch. 6: 85, 1830.

Almost cosmopolitan.

The names included in this list which are new to Hawaiian literature are *spinofemora*, *hydei*, *mercatorum*, *montium* (?), *ananassae*, and *simulans*.

The only satisfactory method of separating specimens of *D. simulans* and *D. melanogaster* appears to be the use of the shapes of parts of the male terminalia. The claspers and the processes of the genital arches of the males are clearly distinct (see figs. *g* and *h*). I have not been able satisfactorily to separate the females by the use of external characters.

In so far as I know, no endemic species of *Drosophila* have been captured in the lowlands outside of the native forest. Like so many other native insects, they have been unable to withstand the pres-

sure brought about by the drastic upset of the lowland environment since man so greatly altered conditions. Thus, it is believed that all of the species of the genus found breeding in the lowlands, about markets and houses and in fields of cultivated crops are most probably immigrant species. The number of endemic species is very large—Perkins estimated that about 250 could be found if searched for—but they are inadequately known. Forty eight native species have been described, and some of these are the most unusual of the genus.

KEY TO THE IMMIGRANT SPECIES OF DROSOPHILA

1. Dorsum of thorax greyish, appearing dark, conspicuously speckled.....2
 Dorsum of thorax yellowish or reddish, without numerous dark spots.....3
- 2(1). The lateral expansions of the dark bands of the abdominal tergites entire, and not containing distinct, pale "islands" as pale as the nota (fig. *i*); costal index (length of the second section of the costa divided by the length of the third section) more than 3 (about 3.5).....*D. hydei* Sturtevant.
 The lateral expansions of the dark bands of the abdominal tergites conspicuously interrupted and containing large, distinct pale areas margined by pigmented areas (fig. *j*), or the pigmented areas partly obsolete or wanting—especially caudad; costal index usually about 2.8.....
 *D. mercatorum* Patterson and Wheeler.
- 3(1). Fourth vein index (distal section of the fourth vein divided by the length of the penultimate section) about 1.5; fore femora armed on the lower inner margin with a row of short, stout spines which are obviously heavier than the adjacent setae (as in fig. *f*).....*D. spinofemora* Patterson and Wheeler.
 Fourth vein index more than 2; fore femora not so armed.....4
- 4(3). Each palpus with but one long, conspicuous bristle obviously differentiated from the other setae.....5
 Each palpus with several prominent bristles.....6
- 5(4). Acrostichal hairs in six rows; male with a very conspicuous, strongly developed, longitudinal, black sex comb on the entire length of each of the first two fore tarsal segments.....
 *D. montium* de Meijere(?).
 Acrostichal hairs in seven or eight rows; males without dorsal tarsal sex combs.....*D. ananassae* Doleschall.
- 6(4). Male genital arch with a large, conspicuous, broad, curved and rather hook-shaped or broadly sickle-shaped, medial plate-like process sharply pointed at the ventro-median corner; shaped as illustrated (fig. *g*).....*D. simulans* Sturtevant.
 Median process of genital arch of male comparatively small and not broad and curved; shaped as illustrated (fig. *h*).....
 *D. melanogaster* Meigen.

KEY TO THE EGGS OF THE IMMIGRANT SPECIES OF DROSOPHILA

With the exception of *D. mercatorum* and *D. hydei*, rather good characters are displayed by the eggs of our species, and most of them are easily separated (I have not seen the eggs of *D. montium*, but they have two filaments). The examination of the eggs is facili-

tated by floating them in a small drop of water on a black background—a piece of card coated with India ink is satisfactory.

1. Eggs with two filaments.....2
Eggs with four filaments.....4
- 2(1). Filaments comparatively thread-like, long and slender and not distinctly expanded distad (fig. *k*).....*D. ananassae* Doleschall.
Filaments either slightly or distinctly broadened and flattened beyond the middle as in figs. *m* and *o*.....3
- 3(2). Filaments rather abruptly expanded and markedly broadened distad, decidedly club-shaped, as in fig. *m*.....*D. melanogaster* Meigen.
Filaments gradually and slightly expanded distad as in fig. *o*.....*D. simulans* Sturtevant.
- 4(1). Anterior filaments distinctly narrower than the posterior pair (fig. *p*).....*D. spinofemora* Patterson and Wheeler.
Anterior and posterior filaments of approximately equal diameters—all very slender (figs. *l*, *n*).....*D. mercatorum* Patterson and Wheeler and *D. hydei* Sturtevant.

The eggs of *D. mercatorum* and *D. hydei* are similar, and a cursory study revealed no outstanding characters to use in separating them. However, it appears that, in general, the filaments on the eggs of *D. hydei* tend to remain straighter than those of *D. mercatorum* (see figs. *l* and *n*).

KEY TO THE PUPARIA OF THE IMMIGRANT SPECIES OF DROSOPHILA

1. Stalks of the anterior spiracles greatly elongate, much longer than the longest tubes of the spiracles, fully twice as long as the breadth of the anterior end of the puparium; the stalk plus the spiracle more than one-half as long as the puparium (fig. *a*).....*D. spinofemora* Patterson and Wheeler.
Stalks of the anterior spiracles not distinctly longer than the longest tubes of the spiracles and not as long, or only about as long as the breadth of the anterior end of the puparium; the stalk plus the spiracle less than one-half the length of the puparium (figs. *b*, *c*).....2
- 2(1). The distance between the bases of the stalks of the anterior spiracles less than the length of a stalk (fig. *c*).....3
The distance between the bases of the stalks of the anterior spiracles greater than the length of a stalk (fig. *b*).....4
- 3(2). Posterior spiracles strongly divergent (fig. *e*); greatest breadth of the puparium divided into the length, including the posterior spiracles, equals about 3.....*D. mercatorum* Patterson and Wheeler.
Posterior spiracles not strongly divergent (fig. *d*); greatest breadth of the puparium divided into the length, as above, equals about 4.....*D. hydei* Sturtevant.
- 4(2). Anterior spiracles with about 10 or 12 tubes.....*D. ananassae* Doleschall.
Anterior spiracles with about 6 to 8 tubes.....*D. simulans* Sturtevant and *D. melanogaster* Meigen.

I have not seen the puparium of *D. montium*. The puparium of *D. hydei* is paler and distinctly more slender than that of *D. mercatorum*. These last two species have about 15-16 tubes in the anterior spiracles.

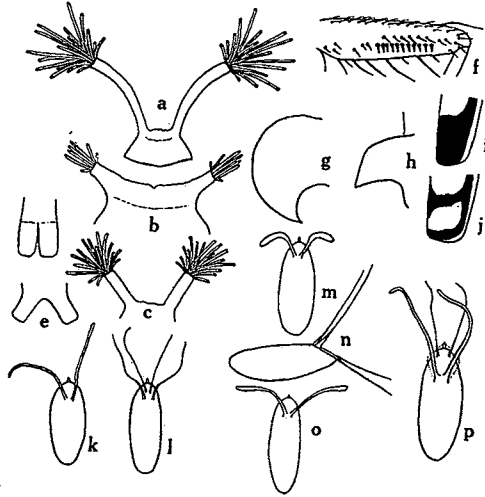


Fig. 1.—Diagrams of features of immigrant species of *Drosophila*: a, "horns" and anterior spiracles of *D. spinofemora*; b, the same of *D. simulans*; c, the same of *D. mercatorum*; d, posterior spiracles of *D. hydei*; e, the same of *D. mercatorum*; f, fore femora of *D. spinofemora*; g, process on male genital arch of *D. simulans*; h, the same of *D. melanogaster*; i, diagram of color pattern on side of an abdominal tergite of *D. hydei* (the middle area of the dark zone may be somewhat paler than the marginal zones—the intensity of the pigmentation is variable); j, the same of *D. mercatorum* (the contrast is exaggerated here; some specimens have the dark markings indistinct and have a pale and "washed out" appearance as compared to *D. hydei*); k, egg of *D. ananassae*; l, egg of *D. mercatorum*; m, egg of *D. melanogaster*; n, egg of *D. hydei*; o, egg of *D. simulans*; p, egg of *D. spinofemora*.

On the Establishment of the Order Trichoptera in Hawaii

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Immigrant species new to our fauna are continually being found, but it is rare that a representative of an *order* hitherto unrepresented in Hawaii is recorded. In October, 1940, I collected a series